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ABSTRACT

Research on the effectiveness of science writing can be considered in three categories: audience characteristics, effects of scientific communication, and source/receiver relations. Audience research indicates that interest in problems may vary according to proximity to the problem, demographic criteria, and level of general concern with social problems. Research on the effects of scientific communication has shown that increasing understanding of scientific issues depends on the program discussed and on the audience. Also, word difficulty and syntactic complexity are important to comprehension. There is some indication that message effectiveness may be increased by the use of analogy. Research on source/receiver relations indicates that most science articles are at least partially inaccurate. A seminar between scientists and science editors indicated that editors write according to what they think will be of interest to readers while scientists are trying to teach people what is new and important. Further research needs to be done in areas such as processes of communication, consideration of communication as a dependent variable, the link between message structure and cognition, and situational factors. (TJ)

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SCIENCE WRITING TECHNIQUES AND METHODS: WHAT THE RESEARCH TELLS US

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

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While science writing and reporting have achieved increased status as a profession, little has been done, as Funkhouser and Maccoby (1971) suggested a few years ago, to undertake systematic research to advance it as a discipline. Despite what progress that has been made in improving science writing, too many scientists still report that they are disturbed by the treatment their own research and practices receive from the media. Nor are editors always confident that they have faithfully related the nuances of issues which involve complex technical questions to the public.

As we know only too well, the media do not always turn to researchers to assist their efforts at professionalism. If they did, what could we really tell them about improved reporting of cancer cures or correctly describing how "test tube" babies develop? Possibly nothing on topics this specific and so potentially sensational. But we might be able to give the science writer some insight into what constitutes scientific information in the minds of reporters and consumers and what their audience is like.

We were recently asked questions of this kind by a major corporation concerned with communicating the problems of nuclear waste disposal to the general public. We reviewed much of the literature on science writing, diffusion of technical innovations, advertising, public relations and so on (see Bowes et. al., 1978). What we found left much to be desired, yet it was provocative and potentially useful to science writers. We organized our comments into three major areas suggested by the materials themselves: audience characteristics -- primarily attitudes and opinions toward science and technological change; effects of scientific communication -- primarily the kinds of changes made in people's thinking by science writing; and finally, perhaps most critically, source-receiver relations -- the accuracy of the communication link between these groups. Let me briefly summarize our basic findings and criticisms in that order.

Among communications professionals, one of the adages is "know your audience". This need is taken seriously judging from the bulk of information dealing with audiences for scientific information. By knowing audience attitudes, one presumably is better able to communicate with the audience on their terms. But what if communication purposes are at variance with prevailing attitudes? Should the reporter remain silent? And what guarantee exists that if messages "agree" with attitudes that this will reflect in audience behaviors? Much of this notion, of course, smacks of the engineering of consent rather than informing audiences.

One of the most useful aspects of the attitudinal data was that it allowed us to test for individual differences in audiences. This

stratification could suggest to reporters the problems of communicating to various subgroups. However, neither the situation reported or the audience segment itself promised much stability from case to case. Interest in environmental problems, for example, has been shown to vary by (1) proximity to problem (Kronus & Van Es, 1976; Tichenor and Bowers, 1971); (2) demographic criteria such as class, education, income, political affiliation and employment; and (3) level of general concern with social problems. Doubtless other factors impinge as well....and to accommodate all their needs in a given message would be impossible.

The diffusion literature provided another perspective for dealing with audiences. Here attention is on the individual's ability to adopt and use the innovations of science and technology. Several roles are commonly seen for communication in this process: creating awareness, establishing utility and social acceptability and developing necessary expertise in using technology. But this research differed from that previously discussed. It better recognized individual differences in that some are more likely to accept technical change information more readily than others. In this context, researchers such as Grunig and Stamm (see Grunig, 1972 and 1976; Stamm, 1977), recognized the importance of institutional constraints -- the importance of societal structures such as government and organizations -- which can take the option of accepting scientific information away from the individual; fluridation of water, for example.

Communication researchers, in the tradition of advertising and public relations, have been interested in the <u>effects</u> of their messages -- so much so that little interest has been given the communication process which is assumed to intervene a given message and its effect. Few studies deal with how scientific concepts can be best communicated. Nor have many dealt with the levels of audience understanding which results. The gap is serious, for such literature suggests how to obtain certain effects without explanation of principles underlying effective communication. To make matters worse, the literature tends to be pessimistic about obtaining any significant impact on an audience beyond rather limited effects. For example, in two reviews of environmental communication literature, Stamm (1972) found little support for such assumptions that increasing knowledge changes attitudes toward environmental matters, or that attitudes in turn predict behavior. Still, as Grunig concluded in another paper (1977), the prevailing assumption remains that if environmental issues are covered "properly", proper attitudes will develop toward the issue.

Even the simple proposition that information programs increase public understanding of science and technology must be qualified. It depends, among other things, on the program discussed and the audience. Tichenor, Donohue and Olien (1970), for example, noted that

information programs often increase the gap between the most and least informed members of the audience. Other studies, primarily by Bowes and Stamm (see Ludtke, et. al., 1971 and Bowes and Stamm, 1974), found deficiencies in technical information programs despite "good faith" efforts by responsible agencies. Some examples: (1) citizens affected by a large water management project saw outcomes simplistically as either one primary advantage or disadvantage -- the subtleties of cost/benefit were not recognized; (2) Citizens in several development projects lacked basic knowledge of where to get more information, how to have input to decisions and even what agencies were responsible for the project; (3) Local media failed to describe impacts of projects in terms of citizens' lifestyle.....coverage tended to be merely descriptive without much interpretation.

Journalists should be interested in message structure and its importance to audience comprehension of science and technology. The first research of this type attempted to vary word difficulty and syntactical complexity in a way similar to traditional "readability" studies prevalent in elementary education. A second approach might be termed "interpretation". Here the effort is to make new and abstract ideas understandable by relating them to similar, but more familiar ideas. The skillful use of analogy and metaphor is seen frequently in the work of such science interpretors as Asimov, Leopold, Dubos and others. Funkhauser and Maccoby (1972) and later Grunig (1974) examined the proposition that analogy would be effective for scientifically inexperienced readers. According to Grunig, the use of examples simply provided an operationalization of the scientific concept discussed, while analogy preserved the same level of abstraction as the original concept. However, stronger influences came from the reader's relation to the concept -- such as its perceived utility in decision-making or problem-solving. In short, message variables made a difference, but were strongly qualified by what the audience brought to the situation.

Science reporters and writers might also be interested in the extent to which both sources and the receivers strive and achieve a shared understanding of a message. One study (Muchinsky, 1976) compared the ranking of important public issues between oil company executives and college students. The agreement, perhaps surprisingly, was high. But little was said about the communication given responsibility for this understanding. More useful, perhaps, is examining the link between scientists sources and reporters, concentrating on the reporter's role as translator of scientific complexities in making them compelling and understandable to the public. How well this is done is usually up to the scientist-source in evaluating the reporter's work. Tichenor and his colleagues (1970), for example, sampled newspaper accounts of scientific and technical subjects. These materials were then given to novice subjects to read and summarize in their own words. Summaries were returned to scientists who rated their

adequacy. In similar but somewhat less complex studies, Tankard & Ryan (1974) and Broberg (1973) gauged the accuracy of science stories simply by sending them to scientist-sources to be checked. Few were free of error.

Recognizing a problem, NSF held a series of seminars (pScience) in 1973 between scientists and science editors. A basic divergence was clear throughout: editors wrote what they believed would interest their audience, while scientists held to the academic tradition of trying to teach people what they believed was new and important...whether the audience was willing to listen or not. As Tannenbaum (1963) noted, each of these parties values different story elements. Scientists reacted to <u>what</u> is being said while editors considered more <u>how</u> it was said.

Several studies have considered more than one linkage. Bowes & Stamm (1974) compared images of a proposed water management study among 3 major groups: agencies directing development, citizens of the region affected, and community leaders responsible for brokering information between agency and citizens. Since leaders and agencies were to act on behalf of the public -- <u>their</u> understanding of public feeling -- their ability to estimate public views -- toward project costs and benefits was essential. It was clear from results that community leaders were inaccurate in making their estimates. Agencies were better, but leaders remained the primary conveyor of opinion between agencies and the public served. Similar techniques were used by Jain (1970) to test quality of information flows in a scientific community and by Groot (1970) to check the linkages of scientist to extension agent and farmers.

The conditions -- social, individual and message style -- which promote inter-group accuracy have been discussed to some degree. But overall, few have directly investigated this with scientific information. Several studies, however, are notable:

Donohue, Tichenor and Olien (1975) and Tichenor, Olien and Donohew (1976) were concerned with the differences -- gaps -- in knowledge about local environmental issues and nuclear power in small Minnesota communities. Social conflict, smallness and homogeneity of population were forces reducing gaps between the most and the least knowledgeable. The duration and intensity of media coverage also had effect. Some preliminary findings suggested that intense coverage for long periods tended to equalize knowledge among citizens while short-term exposure reached only the highly educated. Unfortunately, long term media attention to scientific policy seems more the exception than the rule. (The effect of coverage intensity and duration is under continuing investigation by Tichenor and his colleagues and is, despite early indications, still an open matter)

Other, perhaps less inspired studies, have dealt with accuracy based

on the similarity of source and receiver (see Alpert & Anderson, 1973). The attributes for testing similarity tended, however, to be demographic and not the attitudinal and personality dimensions which more directly bear on the quality of interpersonal relationships. Too, several studies of this type were more interested in the extent of message diffusion, taking only passing note of the quality of the message received.

There are significant classes of studies which we have largely omitted from this review and critique, owing limitations of time and space. Studies of risk and conflict attendent to technological change describe unique, often difficult environments for communication activity. These are particularly of interest to those testing the impact of nuclear power facilities. Understandably, many of these studies spend their time describing audiences, attitude change, and public relations techniques. The diffusion literature, an area only touched upon here, is voluminous. Regrettably, much of this work concerns promotion of rather simple technologies in developing nations -- not the more complex technology issues of modern, urban society. We have also given short attention to "readability" research which commands a sizeable interest in education and child development, but tells us little about the explanatory strategies used to convey difficult, abstract scientific concepts.

What, then, is bequeathed to the science reporter/writer from this research activity that is of immediate, practical use? Little, if one is looking for direct matches between research and current editorial problems. The situations and populations considered in the research vary too extensively to permit much more than chance fits to one's present writing dilemmas. Benefit has to come from extrapolation and adaptation. Under these conditions, the picture brightens. For example, one might consider the problems of short vs. long term information campaigns suggested by Tichenor's studies, the techniques for assessing accuracy among groups involved in sharing complex scientific information or the power of metaphor and analogy suggested by Grunig in preserving the abstraction and scientific generalization. Too, attitudinal studies can assist reporters in predicting the level of resistance to or acceptance of technological change. For public relations specialists and others assigned persuasive tasks on behalf of technological interests, this advice meets instrumental needs.

But as researchers, this area perhaps is more provocative for what remains to be done. In a strict sense, this task is never-ending; however, certain needs seem a priority:

1. Much of science writing wants effect: to move audiences to compliance or action. But most studies assume desired behaviors will result from the after-message attitude

shifts, presumably as the result of the message. This "logic" ignores what is adundantly clear to many communication practitioners: their audience is really controlling the communication situation by deciding how, when and whether to attend to the message. The presumption of communication effect really isn't adequate. Processes of communication must be better described and systematically tested from the viewpoint of both the message creators and the audience within the same study. The quality of this source-receiver linkage is pivotal.

2. We have rarely considered communication as a dependent variable -- the outcome of some anticedent condition such as confusion, a need to establish control, problem solve, or form questions. What leads us to seek information or communicate concerning science might possibly be quite productive as a research perspective -- especially since science information seems rarely sought out as entertainment from mass media.

3. We know little about mechanisms which preserve the abstract quality of scientific generalizations, yet render them more easily understood. Moreover, the complex systemic relationships scientific generalizations may bear to each other may confuse further. Grunig discussed the potential of the metaphore and the analogy in clarifying scientific concepts, but these seem just a start in what seems to be an important research direction.

4. This problem suggests a more general one of linking message structure to cognition. What are those structures which best allow scientists to share their meaning for phenomina with the lay public? And what are the important characteristics of this sharing which can be measured while recognizing the uniqueness of a given communication event?

5. We know little about the ability of reporters to handle scientific data themselves -- to check viability of conclusions drawn and interpret them accurately. Methods exist to check this capacity, but we know little that is generalizable about good science writers verses poor ones. Training, experience, the reporter's concept of the audience, reporting strategies are all potentially important.

6. While some research on situational factors -- crises, high risk, conflict -- have been examined particularly with nuclear energy information, the study of them is far from complete. Given the pressures on scientific writing described earlier, we should know more about the communica-

tion needs these situations impose.

With so many basics yet to be systematically understood about science writing, unquestioning reliance on existing research is not possible. However, current findings are useful as suggestions.....in finding explanatory devices, checking audience needs and in testing the accuracy of communication among diverse groups. But prescriptive acceptance of them as effective and universally applicable may contribute more to failure than success of communication. It is wise to remember the slim, situationally constrained bases upon which much of this advice has been developed.

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